Constraints on the Effective Viscosity of the Lower Crust in the Ventura Basin Region From Viscoelastic Models and GPS Observations

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The velocity field observed using GPS in the Ventura basin region is quite heterogeneous. There is a large velocity gradient across the basin, with 5-7 mm/yr of convergence occurring across distances of < 15 km; outside the basin, the rate of dilatation is an order of magnitude smaller, Elastic dislocation models driven by slip on deep extensions of the thrust faults bounding the basin can explain the observed deformation near the basin if the locking depth of these faults is c 10 km. But these dislocation models also predict (unobserved) extension in the far field. Geologic models of fault-bend folding share this shortcoming.

We investigate a (2-I)) model comprised of an elastic upper crust overlying a viscoelastic lower crust. We prescribe constant horizontal velocities in the far field, and prescribe periodic earthquakes at 300 year intervals on the thrust faults bounding the basin. In this model, the lower crust deforms approximately by pure shear, with horizontal shortening accompanied by crustal thickening, eliminating the (unobserved) extensional deformation in the far field.

If the Maxwell time of the lower crust is ≤ 30 years, velocity variations during the earthquake cycle propagate > 100 km from the faults, with the velocity gradient in the latter part of the seismic cycle too smooth to match the GPS observations. For Maxwell times ≥ 500 years (lower crustal effective viscosities>1020"8 Pa s), strain is localized near the faults, in agreement with observations. 'l'his viscosity is higher than that inferred from investigations of the San Andreas fault, suggesting a colder thermal regime, which is consistent with anomalously deep seismicity and low heat flow near the Ventura basin,

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